AMENDMENTS TO THE CLAIMS

Listing of Claims

1. (Original) A method of mirroring data in a computer network, comprising the steps of:

establishing at least one connection between a local storage server and a mirror storage server;

receiving a primary storage request from a network host at the local storage server;

sending a mirror storage request across the established at least one connection from the local storage server to the mirror storage server, wherein the mirror storage request corresponds to the received primary storage request;

processing the mirror storage request at the mirror storage server;

sending a first heartbeat signal from the local storage server to the mirror storage server; and

sending a second heartbeat signal from the mirror storage server to the local storage server.

2. (Original) The method of claim 1, further comprising the steps of:

detecting an interruption in the second heartbeat signal at the local storage server;

closing the established at least one connection; and

queuing mirror storage requests that result from primary storage requests that are received during the detected interruption.

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3. (Original) The method of claim 2, further comprising the steps of:

receiving the second heartbeat signal at the local storage server after the detected interruption of the second heartbeat signal; and

re-establishing the closed at least one connection between the local storage server and the mirror storage server.

4. (Original) The method of claim 3, wherein said mirror storage request sending step comprises the step of:

sending the queued mirror storage requests across the re-established at least one connection after said re-establishing step.

5. (Original) The method of claim 4, wherein said detecting step comprises the step of:

detecting an interruption in the second heartbeat signal at the local storage server that has a duration longer than a first predetermined amount of time.

6. (Original) The method of claim 3, wherein said re-establishing step comprises the steps of:

monitoring the second heartbeat signal for a probationary interval of time; and

re-establishing the closed at least one connection between the local storage server and the mirror storage server only if no interruptions in the second heartbeat signal are detected during said monitoring step.

7. (Original) The method of claim 1, wherein said processing step comprises the step of:

storing data of the received mirror storage request in a mirror storage device corresponding to a primary storage device.

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8. (Original) The method of claim 7, further comprising the step of:

sending a response across the established at least one connection from the mirror storage server to the local storage server, wherein the response indicates whether said storing data step was successful.

9. (Original) The method of claim 5, wherein said establishing step comprises the steps of:

establishing *n* connections between the local storage server and the mirror storage server, wherein each of the *n* connections is between one of *n* worker threads in the local storage server and one of *n* connection threads in the mirror storage server, wherein $n \geq 1$;

storing a local connection array of *n* elements on the local storage server, wherein each element of the local connection array corresponds to one of the *n* local worker thread that operates on the local storage server; and

storing a mirror connection array of *n* elements on the mirror storage server, wherein each element of the mirror connection array corresponds to one of the *n* connection threads on the mirror storage server.

10. (Original) The method of claim 9, wherein said local connection array storing step comprises the step of:

storing a local connection array of *n* elements, wherein each element comprises a socket and a timestamp; and

wherein said mirror connection array storing step comprises the step of:

storing a mirror connection array of *n* elements, wherein each element comprises a socket parameter and a timestamp parameter.

11. (Original) The method of claim 10, wherein said establishing step further comprises the step of:

establishing each of the *n* connections according to the socket parameter stored in the corresponding one of the *n* elements of the stored local connection array.

12. (Original) The method of claim 11, further comprising the steps of:

establishing a mirror heartbeat sender thread and a mirror heartbeat receiver thread in the mirror storage server; and

establishing a local heartbeat sender thread and a local heartbeat receiver thread in the local storage server.

13. (Original) The method of claim 12, wherein the first heartbeat signal sending step and said second heartbeat signal sending step each further comprise the step of:

sending a message at time intervals of a second predetermined amount of time.

14. (Original) The method of claim 13, wherein said first heartbeat signal sending step further comprises the step of:

updating the timestamp parameter of each of the *n* elements of the mirror connection array whenever the message on the first heartbeat signal is received by the mirror heartbeat receiver thread; and

wherein said second heartbeat signal sending step further comprises the step of:

updating the timestamp parameter of each of the *n* elements of the local connection array whenever the message on the second heartbeat signal is received by the local heartbeat receiver thread.

15. (Original) The method of claim 14, wherein said detecting step further comprises the step of:

indicating in one of the *n* elements of the mirror connection array that the corresponding one of the established *n* connections is closed if the timestamp parameter of the one of the *n* elements is older than the first predetermined amount of time.

16. (Original) The method of claim 15, wherein said closing step comprises the steps of:

timing out one of the *n* connection threads on the mirror storage server if a request on the corresponding one of the established *n* connections has not arrived in a third predetermined amount of time; and

closing and exiting the timed out connection thread if the corresponding one of the *n* elements in the mirror connection array is indicated to be closed.

17. (Original) The method of claim 16, further comprising the steps of:

receiving a first message on the first heartbeat signal after an interruption of the first heartbeat signal; and

re-establishing the *n* connections between the local storage server and the corresponding connection threads on the mirror storage server.

18. (Original) The method of claim 17, wherein said second heartbeat signal receiving step comprises the step of:

receiving a first message on the second heartbeat signal after an interruption of the second heartbeat signal.

19. (Original) The method of claim 1, wherein the local storage server is operating in an asynchronous mirror mode, further comprising the steps of:

processing the primary storage request; and

sending the results of the processed primary storage request to the network host.

20. (Original) The method of claim 1, wherein the local storage server is operating in a synchronous mirror mode, further comprising the steps of:

processing the primary storage request;

waiting for a response corresponding to the sent mirror storage request from the mirror storage server; and

sending the results of the processed primary storage request to the network host after the response is received from the mirror storage server.

21. (Original) The method of claim 1, further comprising the step of:

determining whether a LUN related to the received primary storage request is designated to be mirrored.

22. (Original) The method of claim 1, wherein the established at least one connection is a TCP connection.

23. (Original) The method of claim 13, wherein said sending a message steps each comprise the step of:

sending a user datagram protocol message at time intervals of the second predetermined amount of time.

24. (Original) A method of bi-directional mirroring of data in computer networks, comprising the steps of:

establishing a first connection between a local storage server and a remote storage server;

establishing a second connection between the local storage server and the remote storage server;

receiving a first local storage request from a first network host at the local storage server;

sending a first local mirror storage request from the local storage server across the first connection, wherein the first local mirror storage request corresponds to the first received local storage request;

receiving the first local mirror storage request at the remote storage server;

storing data received in the first local mirror storage request in at least one remote storage device coupled to the remote storage server;

receiving a first remote storage request from a second network host at the remote storage server;

sending a first remote mirror storage request from the remote storage server across the second connection, wherein the first remote mirror storage request corresponds to the received first remote storage request;

receiving the first remote mirror storage request at the local storage server; and

storing data received in the first remote mirror storage request in at least one local storage device coupled to the local storage server.

25. (Original) The method of claim 24, further comprising the steps of:

sending a first heartbeat signal from the local storage server to the mirror storage server; and

sending a second heartbeat signal from the remote storage server to the local storage server.

26. (Original) The method of claim 25, further comprising the steps of:

detecting an interruption in the second heartbeat signal at the local storage server;

closing the established first connection;

receiving at least a second local storage request at the local storage server; and

queuing at least a second local mirror storage request at the local storage server, wherein the at least a second local mirror storage request corresponds to the received at least a second local storage request.

27. (Original) The method of claim 26 further comprising the steps of:

receiving the second heartbeat signal at the local storage server after the detected interruption of the second heartbeat signal; and

re-establishing the closed first connection between the local storage server and the mirror storage server.

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28. (Original) The method of claim 27, further comprising the step of:

sending the queued at least a second local mirror storage request across the re-established first connection after said re-establishing step.

29. (Original) The method of claim 25, further comprising the steps of:

detecting an interruption in the first heartbeat signal at the remote storage server;

closing the established second connection;

receiving at least a second remote storage request at the remote storage server; and

queuing the at least a second remote mirror storage request at the remote storage server, wherein the at least a second remote mirror storage request corresponds to the received at least a second remote storage request.

30. (Original) The method of claim 29, further comprising the steps of:

receiving the first heartbeat signal at the remote storage server after the detected interruption of the first heartbeat signal; and

re-establishing the closed second connection between the local storage server and the mirror storage server.

31. (Original) The method of claim 30, further comprising the step of:

sending the queued at least a second remote mirror storage request across the re-established second connection after said re-establishing step.

32. (Original) A system for mirroring data in a computer network, comprising:

a local storage server that receives a storage request and outputs a mirror storage request, wherein said local storage server outputs a first heartbeat signal; and

a mirror storage server that receives said mirror storage request, wherein said mirror storage server processes said mirror storage request, wherein said mirror

storage server outputs a response corresponding to said mirror storage request to said local storage server, wherein said mirror storage server outputs a second heartbeat signal and receives said first heartbeat signal;

wherein said local storage server receives said second heartbeat signal.

33. (Original) The system of claim 32, wherein said local storage server comprises:

a local work thread generator module that generates *n* local worker threads; and

a local connection array that includes *n* elements; and

wherein said a mirror storage server comprises:

a mirror connection array that comprises *n* elements; and

a mirror connection thread generator module that generates *n* mirror connection threads.

34. (Original) The system of claim 33, wherein each of said *n* mirror connection threads are connected to a corresponding one of said *n* local worker threads using a corresponding socket parameter stored in each of said *n* elements of said mirror connection array to form *n* corresponding connections.

35. (Original) The system of claim 34, wherein said local storage server comprises:

a local heartbeat thread generator module that generates a local heartbeat sender thread and a local heartbeat receiver thread; and

wherein said mirror storage server comprises:

a mirror heartbeat thread generator module that generates a mirror heartbeat sender thread and a mirror heartbeat receiver thread;

wherein said local heartbeat sender thread sends said first heartbeat signal to said mirror heartbeat receiver thread, and said mirror heartbeat sender thread sends said second heartbeat signal to said local heartbeat receiver thread.

36. (Original) The system of claim 35, wherein each of *n* elements of said local connection array comprises a timestamp parameter, wherein said local heartbeat receiver thread updates each said timestamp parameter in said local connection array when a message is received on said second heartbeat signal.

37. (Original) The system of claim 36, wherein said local heartbeat sender thread indicates in at least one of the *n* elements of the mirror connection array that the corresponding at least one of the established *n* connections is closed if the corresponding timestamp parameter is older than the first predetermined amount of time.

38. (Original) The system of claim 36, wherein one of said *n* mirror connection threads times out if a corresponding mirror storage request is not received from said local storage server for a second predetermined amount of time, wherein after said time out said one of said *n* mirror connection threads checks the timestamp of the corresponding one of the *n* elements and exits if said corresponding timestamp is older than a second predetermined amount of time.

39. (Original) A computer program product comprising a computer useable medium having computer program logic recorded thereon for enabling at least one processor to mirror data in a computer network, said computer program logic comprising:

means for enabling the processor to establish at least one connection between a local storage server and a mirror storage server;

means for enabling the processor to receive a primary storage request from a network host at the local storage server;

means for enabling the processor to send a mirror storage request across the established at least one connection from the local storage server to the mirror storage server, wherein the mirror storage request corresponds to the received primary storage request;

means for enabling the processor to send a first heartbeat signal from the local storage server to the mirror storage server; and

means for enabling the processor to send a second heartbeat signal from the mirror storage server to the local storage server.

40. (Original) The computer program product of claim 39, further comprising:

means for enabling the processor to detect an interruption in the second heartbeat signal at the local storage server; and

means for enabling the processor to queue mirror storage requests that result from primary storage requests that are received during the detected interruption.

41. (Original) The computer program product of claim 40, further comprising:

means for enabling the processor to receive the second heartbeat signal at the local storage server after the detected interruption of the second heartbeat signal; and

means for enabling the processor to re-establish the closed at least one connection between the local storage server and the mirror storage server.

42. (Original) The computer program product of claim 41, further comprising:

means for enabling the processor to send the queued mirror storage requests across the re-established at least one connection.

43. (Original) The method of claim 39, further comprising the step of:

means for enabling the processor to receive a response across the established at least one connection from the mirror storage server, wherein the response indicates whether data in said sent mirror storage request was successfully stored in a mirror storage device.

44. (New) The method of claim 1, wherein at least one of the step of sending a first heartbeat signal and the step of sending a second heartbeat signal includes:

periodically sending a User Datagram Protocol (UDP) message.

45. (New) The method of claim 25, wherein at least one of the step of sending a first heartbeat signal and the step of sending a second heartbeat signal includes:

periodically sending a User Datagram Protocol (UDP) message.

46. (New) The system of claim 32, wherein at least one of the local storage server and the mirror storage server is operable to send the first and second heartbeat signals, respectively, by

periodically sending a User Datagram Protocol (UDP) message.

47. (New) The computer program product of claim 39, wherein at least one of the means for enabling the processor to send a first heartbeat signal and the means for enabling the processor to send a second heartbeat signal includes:

means for periodically sending a User Datagram Protocol (UDP) message.

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